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Do It Yourself Science: Issues of Quality

Inspirational Workshop 3

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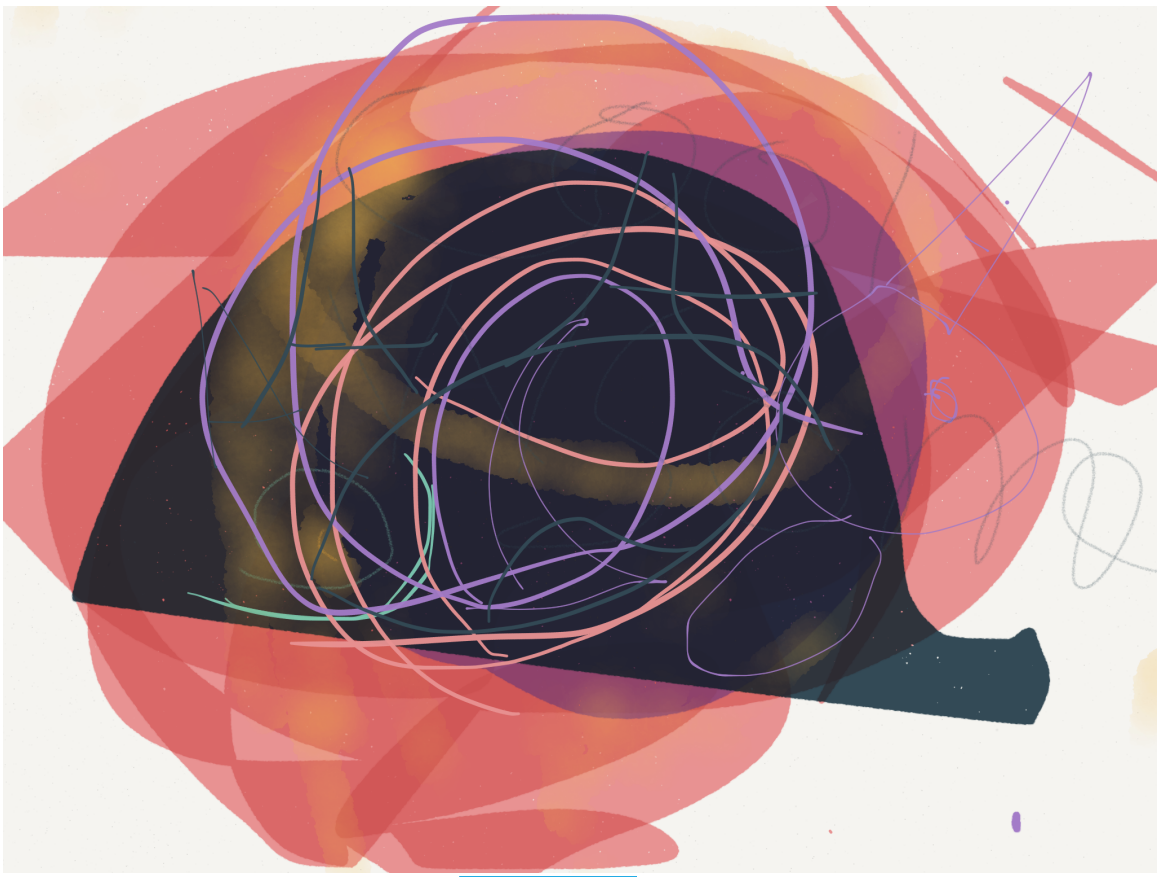

Joint Research Centre

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Summary

DIY Science (Do It Yourself Science) includes a great variety of tendencies, variously described as amateur, 'garage', 'citizens', 'extreme citizen' and activist[1]. Although now small and marginal, they will surely grow, along with their challenges to mainstream science. There will be problems to be resolved, as established science loses its monopoly of accredited status in the provision of knowledge and advice. But the challenge should be productive of new thinking and new practices, enriching science in many ways as the two streams interact.

There are also internal challenges to DIY Science. Salient among these is the quality assurance of scientific production. Up to now this has been supported by rigid structures of status, that determine who is entitled to be recognised as a 'scientist'. That status is required for gaining access to the resources that support both research and publication. The system is designed, in part, to protect science against the worst excesses of fraud and charlatanism. In the new and untested forms of social practice of DIY Science, quality assurance will need to be reconstructed in the absence of established institutions of status. There is a already a new ethic for knowledge in open communities of invention, that is well described as 'creative commons', which could serve as an example and guide for DIY Science.

This workshop invited a group of scholars and practitioners who are committed to the discussion of these important issues, both the interactions with established science and the quality assurance of DIY Science.

The workshop concluded with more questions and answers living it clear that these conversations on quality should be continuously pursued. The following are **main reflections from the workshop conversations**.

- ***DIY Science*: paradoxical and emergent**

  As a social practice, DIY Science is no more than nascent. The label is somewhat paradoxical, as it combines two terms that derive from very different areas of activity. That paradoxical label serves to emphasise the potential importance of the field of activity. By its definition it breaks the rules by which we understand 'science'.

- ***Quality Assurance needs rethinking***

  Given on-going challenges to integrity of mainstream science, the prospects for effective quality assurance in DIY Science are dubious. Quality assurance in science is a remarkable institution, as it works largely informally on the contribution of unpaid volunteers. It has worked well in the past but it has been increasingly coming under stress being a sign of the need for a new view of science, as a social activity and in society. Without effective quality assurance, any sort of scientific activity, but especially that which lacks solid institutional

[1] See Nascimento, Guimarães Pereira and Ghezzi, 2014.

foundations and constraints, is very much at risk from every sort of abuse: cranks, charlatans, liars, thieves, and malefactors.

- ***Morale and commitment as necessary conditions***

At the workshop, morale and commitment were deemed as the necessary conditions for effective quality assurance; in their absence vigilance will decrease and shoddy or dishonest work will ensue. So the community aspect of DIY Science was stressed, deriving either from participation in a good cause, or involvement in an idealistic community.

- ***Who judges quality?***

In the absence of established institutions for governance, we realise more acutely that doing science involves choices, that we inevitably leave most areas in ignorance. Again, who makes those choices, by what right do they do so, and to what extent are those choices public and accountable, become salient questions in the DIY context. The inevitable struggles to achieve worthwhile knowledge are here not buried in the objective language of research papers, or concealed in unpublished papers if unsuccessful. Issues of quality and excellence, only recently becoming salient in mainstream science, are in the DIY context absolutely central. Who judges quality, with what competence and by what right, are issues that cannot be avoided.

- ***Challenges to mainstream science***

The practice of DIY Science does not merely raise issues about the conduct of science that had previously been underrated. In very practical ways, it creates challenges to mainstream science with reminders that alternative approaches and styles are possible. By embedding science in communities, either local or issue-oriented, it highlights the isolation of mainstream scientific practice from the society that supports it. Similarly, DIY researchers are not insulated, or alienated, from the outcomes of their work. They must confront all the issues, practical, political and ethical, that arise from that connection. In that way, they inevitably become 'citizen scientists', and show that that is a natural and healthy status.

Further research is required

DIY Science is a relevant knowledge production *locus*. These forms of knowledge production outside and not triggered by scientific institutions need to be recognised as they won't go away. The discussion of their mingling with mainstream science and policy is still in its infancy. **Deep aspects of quality assurance, such as its social, ethical and political significances as well as, the "fitness for purpose" and relevance to deliberate, to empower, to change human action needs to be critically looked at.**

The workshop recommended that further effort needs to be put into looking deeply into the current on-going transformations, which are affecting profoundly the ways we think about sharing and collaboration models in science, innovation and business, intellectual property rights, and last but not least, citizenship.

DIY Science: the challenges of quality

Introduction

What we designated here as *do it yourself Science*[2] (DIY Science) is a deep form of engagement of citizenry with techno-science, where the DIY *scientist* appears as someone who tinkers, hacks, fixes, recreates and assembles objects and systems in creative and unexpected directions, usually using open-source tools and adhering to open paradigms to share knowledge and outputs with others. These are organised into private or community based initiatives that use scientific methods combined with other forms of enquiry to engage with techno-scientific issues and societal challenges.

We have observed (Nascimento *et al.* 2014) that although these movements link well with other changes of the scientific endeavour, such as open science and Citizen Science, perhaps even responding to a crisis of mainstream science (Guimarães Pereira & Saltelli 2014), the 'do it yourself' movement takes us to another dimension of engagement, of greater agency and transformative power of research and innovation. In other words, we think that Alan Irwin's imagination of a "Citizen Science" (Irwin 1995) is gradually emerging and materialising through the on-going DIY Science movement and others alike.

DIY Science includes a great variety of tendencies, variously described as amateur[3], 'garage', 'citizens', 'extreme citizen' and activist. Although now small and marginal, they will surely grow, along with their challenges to mainstream science. There will be problems to be resolved, as established science loses its monopoly of accredited status in the provision of knowledge and advice. But, we argue the challenge should be productive of new thinking and new practices, enriching science in many ways as the two streams interact.

There are also many internal challenges to DIY Science. Salient among these is the quality assurance of scientific production. Up to now in mainstream science, this has been supported by rigid structures of status, that determine who is entitled to be recognised as a 'scientist'. That status is required for gaining access to the resources that support both research and publication. The system is designed, in part, to protect science against the worst excesses of fraud and charlatanism. In the new and untested forms of social practice of DIY Science, quality assurance will need to be reconstructed in the absence of established institutions of status. There has been a new ethic for knowledge in open communities, well described as 'creative commons' (see for example, http://creativecommons.org/). But this would need to be looked at more thoroughly as developments in some areas of DIY Science address issues in contested terrains (e.g., synthetic biology (DIYBio), pollution monitoring, etc.).

This workshop invited a group of scholars and practitioners who are committed to the discussion of these important issues, both the interactions with established science and the quality assurance of DIY Science. It focused on *Quality*, as this is now becoming a very salient

[2] An extensive review of this development is described in Nascimento *et al., Op. cit*.
[3] See Rogers 2011 for critical perspectives of the term.

issue in mainstream science, and it may well become crucial in both DIY Science or Citizen Science.

From a science and technology studies (STS) vantage point, this workshop aimed at contributing to the debate of how different ways of knowing are negotiated and interwoven, since different forms of engagement in knowledge production enact different validation and legitimation processes as well as quality assurance mechanisms.

General Considerations

The workshop on the challenge of quality in DIY Science enjoyed a dialogue among a great multiplicity of perspectives. This is as it should be. As a social practice, DIY Science is no more than nascent. The label is not well known, and it is easily confused with the closely related Citizen Science. It is somewhat paradoxical, as it combines two terms that derive from very different areas of activity. 'Science' conjures up an image of a highly trained, rather special sort of person, working in a rather special sort of institution, producing knowledge that is inaccessible to all but a very few. 'DIY' is just the opposite in all respects. How can there be such a thing as 'DIY Science'? **But that paradoxical label serves to emphasise the potential importance of the field of activity. By its definition it breaks the rules by which we understand 'science'. For many it will be an open question, how it could even be; and on a moment's reflection the challenge of quality will be insuperable.**

Citizen Science and DIY Science

Although the new scientific activities are variable and varied, it is useful to make the distinction above. The term DIY Science derives from the report by Nascimento *et al.* (*Op. cit.*), where both forms of practice are defined and analysed at length. Very briefly, in Citizen Science, the work is done by 'citizens' with close reference to traditional, mainstream science often originated in scientific institutions. This 'science done by non-scientists' may be organised as an *adjunct*, doing research tasks for which professional scientists are too busy and computers as yet not intelligent enough (examples are annual census of birds or protein unfolding). Or it may be organised as *activism*, doing research tasks which some body of citizens believe should be done by regulatory science but is not. This latter sort of Citizen Science is inevitably political and frequently confrontational, but in any case its actions are usually attached to some mainstream scientific or political institution. On the other hand, in DIY Science the focus is on how the work is done, small-scale, inexpensive or relying on crowd-funding mechanisms and independent of mainstream institutions. It is clear that the categories are not disjoint; most Citizen Science is in a sense DIY. For both DIY Science and Citizen Science there are instances where activities are rather motivated by curiosity or just pleasure. DIY Science is a useful focus for inquiry, for in it, many of the structures, social and intellectual, that have defined mainstream science are still to be created. The challenges are correspondingly clear.

Driving Forces and Enabling Circumstances behind DIY Science

The total transformation of the means of scientific communication, and the revolution in the means of scientific production have both been on-going for some decades. There has always been strong public interest in science, and a flourishing 'adjunct-citizen' science in a variety of fields, such as ornithology and astronomy (see e.g. Bonney 2008; Raddick *et al. 2010;* Roy *et al.* 2012). Its function has generally been to assist the real scientists, doing less skilled tasks that have not been automated. Thanks to Information and Communication Technologies (ICT), this sort of activity has been enormously enlarged and enhanced, as in Zooniverse at Oxford University (see https://www.zooniverse.org/). With 'DIY Science', more active forms of engagement with science are witnessed. Developments in 'DIY Science', are operating more independently of mainstream science; some are mildly motivated by scientific curiosity and enjoying the collapse in costs of research in many areas, but also, in many cases, citizens do studies that should have been done by regulatory scientists, in order to highlight environmental or social issues. Previously limited to 'housewives' epidemiology' performed by citizens with clipboards, and generally spurned by authorities, this now enjoys sophistication in instrumentation, quality-assurance and political activism. In the U.S.A., Citizen Science is seen through the perspective of the *Jeffersonian* ideal of small-scale initiatives, and enjoys a rather uncritical acclaim in important quarters. In Europe, the European Commission has begun to promote a reform and renovation of science, partly focused on 'open science' (https://ec.europa.eu/digital-agenda/en/open-science), as part of its general agenda of the enhancement of democracy in the Union[4].

Funding of DIY Science and Citizen Science

One of the critiques to Citizen Science has precisely to do with funding distribution. For example, Riesch and Potter (2014) through several interviews to scientists that had been involved in Citizen Science projects found that there were concerns that Citizen Science can be seen as *potentially outsourcing jobs that otherwise paid scientists would do* (*Op. cit.,* 118). Indeed, this is very varied and it also depends on the field of development. The DIYBio labs and activities have benefited from decreasing prices in DNA synthesis techniques, and also from recent events and technological accelerations that have generated used and out-of-date equipment that is today donated or available at low-cost in auctions. An important source of resources is crowd-funding campaigns in Kickstarter and Indiegogo sponsoring new alternative forms of funding and also legitimacy for scientific and technological projects. New possibilities emerge in this regard considering "research objectives that have been left aside because of economic reasons, or which were considered as trivial, pointless or even unethical, can gain in importance as the financial and symbolic support increases and reaches a critical amount. Decisions on the meaning and the importance of innovations and liabilities are partly shifted to a non-expert public sphere." (Seyfried *et al.* 2014, 551). Crowd-funding is indeed an important

[4] Also relevant here is the European Commission funding of initiatives such as "Citizen Observatories" – see http://www.citizen-obs.eu/; and within the digital agenda the prominent 'Citizen Science' initiative: https://ec.europa.eu/digital-agenda/en/citizen-science

source for DIY Science. In terms of personal funding, there are many instances where scientists engaging with DIY Science keep their main jobs.

In relation to Citizen Science, some American educational institutions fund Citizen Science activities for students and the Federal government has an active programme of support. (See https://www.whitehouse.gov/sites/default/files/microsites/ostp/citizen_science_backgrounder_03-23-15.pdf) The White House has even adopted the slogan, 'Open science and innovation: of the people, by the people and for the people', in a Forum with that title (see https://www.whitehouse.gov/blog/2015/09/30/accelerating-use-citizen-science-and-crowdsourcing-address-societal-and-scientific). In Europe, the European Commission is also funding Citizen Science initiatives.

Impacts on mainstream science

There is a great deal of literature that seems to herald Citizen Science as rather beneficial for the development of mainstream science (see Nascimento et al. *Op. cit.* for a review but see also Riesch and Potter *Op. cit.*). So far, the same cannot be said for the DIY Science realm. On the other side, there are a variety of developments whereby mainstream science begins to lose its monolithic, closed character and look more like Citizen Science. In publication, the rise of pre-publication channels and of blogs breaks the monopoly of paper journals with their anonymous reviewers. It also enables the participation of 'extended peer communities' (Funtowicz and Ravetz, 1992; 1993). Further, scientists now feel free to run activist campaigns on issues of concern, as when Sir Timothy Gowers organised a boycott of Elsevier[5]. Certainly, the idea of a young scientist also being an activist will no longer seem as strange and abhorrent as in the past. *Scientific American* features a blog by an African-American woman with the title 'Urban Scientist'. ("A hip hop maven blogs on **urban** ecology, evolutionary biology & diversity in the sciences.") (https://blogs.**scientificamerican**.com/**urban-scientist/**) This is a very long way from the traditional white-coated bespectacled male holding up his test-tube.

In the other direction, the freeze in employment of researchers has sent some (probably not many) to the DIY sector. This would certainly need further enquiry. We can expect that when many hundreds of thousands of 'citizens' have participated in recognised 'science' (as in Zooniverse, but also activist campaigns and in schools), the exclusive mystique of the status 'scientist' will be eroded. It is impossible to anticipate what effects this will have on the social position of science, but they may be profound.

Ethics

Ethics is important in DIY Science, since it is partly driven by a sense of grievance at the institutions that should be protecting a community but are seen as failing. Its importance should not be overestimated in other areas, just as it is not a central issue in traditional research science. Where fields are inherently hazardous, as garage biology, modern ethical concerns are of course present, and illuminating debates took place there almost as soon as research became organised (see Nascimento *et al. Op. cit.)*.

Future?

It is all too easy for observers to romanticise the Citizen or DIY Science movement, and to find there the solution to all their worries about science. It is, as yet, minuscule in size and insignificant in impact. It is totally heterogeneous in respect of its recruitment, motivations,

[5] See https://gowers.wordpress.com/2013/01/28/the-elsevier-boycott-one-year-on/

and engagement with mainstream science and the broader society. It is quite likely that as soon as it is large enough for strategic choices to need to be made, it will succumb to factional splits and co-optation by external forces. There is just one source of optimism: the persistence of a related movement in information technology. The mainstream sector is organised around property rights, traditionally managed through the patent system. But with movements like 'open source' and 'creative commons', a creative activity with an ethic of trust and sharing has persisted and demonstrated its effectiveness on a competitive market. Whether this could be translated to the system of informal property rights operating in the production of knowledge is quite an open question. It could be one of the most important of our time.

Conversations

In this section we give an account of the conversations held at the workshop, highlighting the questions asked and the main outcomes of those sessions.

Citizen Science

DIY without scientism, Tom Wakeford, Coventry University, UK

Among those making the decisions about our future, quality in science is based on a combination of scientism and neoliberalism. Scientism sees the physics-based predictive sciences as the only source of reliable knowledge. This philosophy underpins the actions of most of our scientific institutions. Since the end of the Cold War this scientism has formed a global alliance with neoliberal economics. Until the European and US banking crisis of 2008 neoliberalism was seen as the only scientifically justified way of organising society.[6]

This neoliberal scientism has not gone away. Ignoring lessons from history, it renders all knowledge – whether reached through DIY or traditional processes – almost powerless against the application of scientism by large corporations. Many trans-nationals (e.g. computing, fossil fuel, arms and agrochemical) are able to over-ride democratically elected governments and international agencies.

In the face of dangerous climate change, a crisis in the industrialised food system and our surrender of our personal data to the military-industrial complex, radical moves towards participatory democracy are needed, of which DIY Science could be part. It needs to draw on philosophies that can counter scientism. These should provide us with new stories that allow us to re-imagine an epistemology that is compatible with sustainability and human rights. Many useful examples exist at the fringes of European culture or come from non-European cultures in the Global South.

DIY implies something you do alone. It is not a term of a collective. So we need to re-imagine the terms "DIY" and "science" to embrace participatory democracy. Self-critical social movements, working in solidarity with their allied thinkers, are the only forces capable of taming neoliberal scientism and bringing about a more pluralist epistemology. In exploring how to reverse the on-going global trend towards neoliberal scientism I want to ask:

1) What stories of the past can help us imagine a DIY Science that can be used by self-critical social movements?
2) How can we base our science on an equal valuing of professionally-trained scholars with other people whose expertise comes from their life experience?
3) In particular, how do we ensure that our proposed reforms do not perpetuate the institutional racism and other intersectional marginalisations that have tainted the pursuit of science over the last century?

[6] Suggested background readings:
Midgley. M. 2014. Scientism and free-market jihad. Available at: https://www.opendemocracy.net/mary-midgley/scientism-and-freemarket-jihad
Midgley, M. 2014. Science and the imagination: Podcast with Tom Wakeford: http://coventryuniversity.podbean.com/category/critical-thinking/
Pimbert. M.P., Barry B., Berson, A., Tran-Thanh. K. 2010. *Democratising Agricultural Research for Food Sovereignty in West Africa*. IIED. Available at: http://pubs.iied.org/pdfs/14603IIED.pdf
Visvanathan, S. 2009. The Search for Cognitive Justice. Available at: http://www.india-seminar.com/2009/597/597_shiv_visvanathan.htm

becoming countercultural, Dan McQuillan, University of London, Goldsmiths College, UK

The workshop 'DIY Science: the challenges of quality' recognises the emergence of marginal tendencies such as activist Citizen Science. It asks two important questions; firstly, how will the contested relationship with mainstream science develop, and secondly, how will this DIY Science reconstruct ideas of quality assurance outside of mainstream scientific institutions? I suggest that these questions can be approached through the idea of countercultural science.

A counterculture works through cultural formations. It is counter - that is, against the mainstream. It is a hybrid space without a unitary identity, associated with a unique moment in time, a point of shift from the old to the new. Importantly, a counterculture is lived as a transformative experience where the participant is changed through their participation in activities.

Countercultural science is explicitly critical of mainstream science. It questions the claims to method; the claims to reproducibility, the disciplinary culture mobilised through peer review and the institutional capture by power. It questions the idea that orthodox scientific truth can disqualify and exclude other truth claims and to stake a singular right to what is real. It is explicitly linked to the idea of social justice.

Countercultural science is a form of empirical investigation that has no need to be hooked up to a grand narrative and has no ambition to totalise knowledge. It can valorise truths that are non-dual and that go beyond objectivity to include the experiential and the transformative. A countercultural science is a mindful science. As there is no a priori problem with provisional knowledges, it naturally inclines towards the local, the situated and the culturally reflective.

quality and challenges

What I am describing is a social and cultural movement. But it also claims to be a form of science; so how can it deal with fraud and charlatanism? We can position fraud as a specific move in a wider problem, the attempt to gain 'power over'. As such, a countercultural science can draw on a broad genealogy of methods to counter the withdrawal power from the collective. This also has the potential to reinvigorate the idea of 'open' (open data, open science) which is ineffectual without a social critique.

A countercultural science connects with social movements both in structure and in purpose. As a form of science committed to social fairness, countercultural science will find application in struggles where there is some empirical tractability, such as *fracking*, urban development or environmental justice. It will experience repression, and the recent criminalisation of environmental data collection in Wyoming and the infiltration of anti-*fracking* movements are pointers to this. Countercultural science will also find an affinity with marginal and indigenous communities and also, therefore, their still existing modes of knowledge generation.

 # questions

1. What active structures can be created to support DIY Science? What can we learn from Dutch science shops of the 1970s and the UK technology networks of the 1980s, as well as C21st social movements?

2. How can we challenge the separation of observer and observed without losing the rigour of empirical measurement?

3. Can the rapid spread of cheap digital sensors become part of a practice that is both contestational and reflective?

From Citizen Sensing to DIY Science: The Problems and Practices of Making Evidence, Jennifer Gabrys, Goldsmiths College, University of London, UK

The “Citizen Sense” research project investigates the rise of low-cost sensors used by citizens to monitor environments. Air pollution monitoring is one area in which there has been considerable development of citizen-sensing technologies. Through a set of participatory design and practice-led research methods, Citizen Sense has worked with a community in northeastern Pennsylvania, USA, to test citizen-sensing technologies for monitoring air pollution in relation to unconventional natural-gas

production. In the course of citizens undertaking monitoring, citizen-sensing practices have increasingly formalized into DIY and citizen-science activities. The initial monitoring of air pollution data, primarily in the form of particulate matter 2.5 (PM 2.5), has developed into more systematic attempts to analyse air pollution data and present preliminary findings to state and federal regulators and agencies. Yet along the way, numerous contestations have emerged about what counts as "hard data," whether or how low-cost devices might provide data of relevance in comparison to reference monitors, what sort of protocols might need to be in place to ensure the accuracy of data, and who is able to make claims about what citizen-gathered data demonstrates. Given that there is an absence of state or federal air quality monitoring in this rural part of the USA, there are also pressing questions that emerge as to who might be responsible for monitoring air pollution. Citizen sensing, Citizen Science, and DIY Science then become entangled techniques for developing a set of practices to monitor air quality, for developing these monitoring practices into techniques that can make claims and be held accountable, and for arguing that DIY Science is especially necessary in the absence of monitoring undertaken by scientific experts.

Based on this research material, several **questions** emerge in relation to DIY Science, including:

1) How might the less formalised and more experimental engagements with low-cost sensing technologies pose new problems and questions for how citizen *sensing* does or does not become recognised as Citizen Science?

2) What techniques, practices and modes of organisation might be identified as specific to citizen sensing and DIY Science, particularly as the data gathered through these practices is moved toward making claims in relation to concerns about environmental health and exposure; and how are these practices distinct from (rather than reproductive of) more expert-driven scientific practices?

Citizen Science and universality of struggle, Ron Salaj, UNICEF Innovations Lab Kosovo, Kosovo

We are living in a world where our most pressing problems today are problems we have in common: ecology, Internet surveillance, finance, neo-apartheid, intellectual property rights, biogenetics, personal freedoms, etc. But, often these problems are being treated by new emerging apolitical technocratic institutions leaded by experts. Maybe there are certain kinds of the problems they can solve, but what they cannot do is to identify and formulate the true problems. Usually the problems are given to them by the power, hence experts by definition are servants of those in power: they don't really THINK and QUESTION, they just apply their knowledge and expertise to problems defined by the powerful, for example: How to restore stability? How to design austerity measures? How to impose recycling and sustainability policies? etc.

On the other hand, the very process of designing solutions for the problems identified by the power it happen on the top of the state structure, without any or very little consultation with communities affected by the problem. A classic example that I have encountered in Italy is this: a small local Municipality near Brescia introduced waste recycling in private homes. The announcement was made only through the Municipality website and its gazette, using only Italian language to explain procedures and the dates to pick up the recycling bins in Municipality. Thus, completely neglecting the fact that in the Municipality there are migrants with no or very little Italian language knowledge and most of them not familiar with the process of recycling, considering that many of migrants comes from under-developed countries. Isn't this a classic example where the very problem is defined by the power and ready-served to the experts for solving it? Does not this reflect the inability of experts to identify and formulate the true problems? What would happen if the process of introducing the recycling and its importance would have been co-designed with the community (including migrants) themselves in order to respond to cultural differences?

Of course, I am not speaking here for this idea of cheap and artificial multiculturalism, and the hermeneutical imperialist approach that *we must understand each other.* Let's recall here the infamous billboards, issued by KFOR (NATO forces in Kosovo) few years ago, that appeared across Kosovo where a dog and a cat were presented in billboard, hugging each other and followed by a message: "If they can do it, so can you" - in other words if dogs and cats hug each other, why can't Albanians, Serbians and other minorities in Kosovo. Instead, what I mean here is the practical understanding of *struggle* - not with enemy, but solidarity in struggle - or as Slavoj Žižek puts it: "*we* in our culture have our own conflict antagonisms, *they* have their own conflict antagonisms; the only authentic universality is the universality of struggle – i.e. to discover that our struggle is part of the same struggle as their struggle.". Our task is to move beyond the mere tolerance of others towards a positive emancipatory *Leitkultur,* which alone can sustain an authentic coexistence and mixing of different cultures, and to engage in the forthcoming battle for that *Leitkultur. Do not simply respect others, but offer them a common struggle, since our most pressing problems today are problems we have in common* (Žižek, 2012).

Citizen Science precisely represents this step which goes beyond mere tolerance offering an alternative space; in Deleuze & Guattari's words *a striation*, where communities themselves authentically engage in their common struggle and in 'empirical transparency' as a way of holding businesses and authorities to account. Combining this with campaigning and ready availability of internet-connected devices, ranging from mobile phones to do-it-yourself sensors, as well as with principles of Paulo Freire's critical pedagogy, affected communities are engaged in the *universality of struggle*: researching, investigating, reflecting, discovering, co-designing processes and methods, and taking action for the common problems: air and noise pollution, lack of data, weak environmental educational system, etc. In Kosovo's *"Science for Change"* project, Roma and Albanian young people work jointly in their common struggle for ecological disaster and air pollution, as well as they together have co-developed plans, methods and tools to respond to the environmental problems; they probably don't hug each other as the infamous KFOR billboard suggest, but their collaboration and engagement with the problem is much more sophisticated, emancipatory and authentic than KFOR billboards.

There are, of course, many question marks and distrust (coming mainly from authorities and orthodox/conservative scientists and institutions) on Citizen Science methods, tools and approaches, and whether the outcomes of the Citizen Science processes should be trustworthy. We should recall here Niels Bohr who, one day, was taking a visitor home who sees a horse-shoe at his door; the surprised visitor observed that he doesn't believe in the superstition that it brings luck, to what Bohr snapped back: "I also do not believe it; I have it there because I was told that it works also if one does not believe it!" This should be our response to those critiques of Citizen Science: you should encourage, support and collaborate with Citizen Science initiatives because they work even if you don't believe in them.

Main Discussion Outcomes

- The issue of social justice in scientised and scientific matters was discussed. Social justice, an ethical issue, appeared as a 'marker' of quality assurance for both mainstream and DIY Science. This liaises well with the European Commission's lemma of responsible research and innovation (RRI).
- The *DIY* label may not capture well the 'collective' essence of what has been actually described under DIY Science. The label is rooted on the DIYBio initiatives. As a way of demarcation from Citizen Science, the label fits the purpose but most likely a better label needs to be invented.
- "Countercultural science" was suggested as a way to address the questions of the workshop but the term was not adopted.

- More review is needed in relation to other movements that have been practicing and situating science in ways other than what is described as mainstream science.
- A strong point of the discussions was on the legitimation mechanisms of knowledge emerging from these types of citizen engagements in science and technology. How does legitimacy affect resources flows, risk, quality and what happens if one works at the boundary?
- What role for non-scientists in the evaluation of quality of mainstream, citizen, DIY Science? This is important if the consequences of the research or the funding of the research affect people outside the community of commitment that researchers have.

DIY Biology

DIY ethics to improve trust in science and institutions, Mariachiara Tallacchini, University of Milano, IT

"If you can't open it, you don't own it"

In the quite longstanding history of DIY, the main ethical principles have dealt with two major ideals: self-reliance and making something to your own exacting specifications. The hands-on nature of DIY ethics has been traditionally related to providing a sense of individual empowerment, fulfilled agency, personal establishment and accomplishment. Central to this ethics is also the need to link individuals and their communities. These characteristics have been dramatically strengthened by technologies made available in the digital age: several groups of DIYers are now trying to express and explore the values connecting the DIY and the Do-It-Together (DIT)—where everyone and everybody can learn and achieve more through collective making and sharing. The DIY/DIT ethics is thus becoming relevant as a way to create more transparency, reliability and credibility about the knowledge publicly produced for policy purposes.

In the domain of environmental protection and health, a number of cases exist where citizens have started collaborating through DIY technologies with the goal of assessing the quality of data, information, and knowledge that public institutions are using to justify and legitimize their decisions concerning, e.g. levels of pollution and hazards to health. Citizen-produced knowledge has the potential to complement, control, and, where appropriate, criticize science-based public actions in order to help establish a more trusted governance of society. The DIYers' motto "if you can't open it, you don't own it" may thus meaningfully jointly apply to technologies used to build public knowledge and to the functioning of institutional mechanisms in a revised version: "if you can't open it, you can't inhabit it." The social contract is therefore being redefined in terms of a deeper and more direct engagement of citizens in taking care of their lives and their rights.

How can these new practices be shaped and assessed against the more traditional forms of civic entitlements to public life? Which domains and topics can be more easily addressed and tested?

DIYBio and e-waste hacking: A politics of demonstration in times of precariousness, Ana Delgado, University of Bergen, NO

In the latest years there has been an explosion of DIY, maker and hacker spaces in Europe. Such spreading is, to a large extent, enabled by the use of the Internet as a knowledge repository and a site for documentation. Through makers and DIY initiatives, 'hacking' is moving into the everyday life of citizens. This paper explores the collective and political nature of those hacks by reporting on empirical work on e-waste and DIYBio hacking. Using Dewey's experimental approach to politics, we analyse hacks as 'inquiry' to see how they serve to articulate issues of common concern. We argue that DIY and makers hacks raise a multidimensional sort of visibility: They call attention on common issues of

concern such as unsustainable patterns of consumption and disposal or access to knowledge and technology. Furthermore, by making unfinished objects (hacks), they make visible to others that realities such as life and waste are ontologically precarious (they change and can be turned into something else), epistemologically undetermined (can always be modified) and politically accessible. DIY and makers hacks are technical and political demonstrations, they show by doing that things could be done otherwise, and that *you can also do it.* The paper concludes by pointing at a potential 'viral' effect of these politics of demonstrations and the potential problems of such politics. Should technological literacy or even autonomy be demanded from citizens? This can certainly have an empowering effect. Yet, within DIY and makers politics of demonstration, the line between coping with ontological precariousness and accepting political precariousness is blurry. A danger of such acceptance is a transfer of responsibilities previously attributed to the State to the citizenry in basic realms of the everyday life such as health or waste management. Another potential problem of portraying citizens as problem-solvers is the potential outsourcing (performed as crowdsourcing) of ideas and work force from the public to industry under the umbrella of social innovation.

Questions:

- How are DIY and makers projects political?
- What are their 'public' dimensions?
- What is the notion of citizenship at use in these 'Citizen Science' initiatives?

DYI Biotechnology with(out) borders, Christiaan De Koning, Institute for Science, Innovation and Society (InSIS), University of Oxford, UK

Do It Yourself (DIY) science is a rapidly growing phenomenon in the western world. One branch of this movement is that of DIY biotechnology. Individuals, communities and small organisations set up nonconventional local open-community laboratories where like-minded experts and amateurs share materials, tools and knowledge outside the walls of the Establishment of mainstream science. Challenging the Establishment with tenets like creativity, open-access, democratisation, decentralisation, transparency, self-regulation and low costs, these 'biohackers' reengineer life, create art and construct new gadgets with the use of living building blocks – opposed to non-living materials. The rise of this social practise and its potential to sprout unconventional innovations involves also questions and decisions over what constitutes impacts and for whom, and ultimately, which actors will be empowered and held accountable. In the absence of a normative and disciplinary context the governance of DIY biotech knows different scenarios of innovation and quality assurance. Even though the DIYBio community is concentrated in the West, differences in restrictions can already be noticed between the Northern American and Western European contexts – fewer restrictions appear to foster an increase in innovation. Moving beyond the West, the question of regulation and governance stands equally central in developing countries, such as with the unorthodox advances in experimentation with stem cells in India. Here, the mechanisms of self-regulation in innovative biotechnology indicate to potentially pose the characteristics of a double-edged sword; providing a cost-effective and high-paced advantage for avant-garde innovation while simultaneously creating opportunity for 'bad' science and charlatans.

Preaching a new ethic for knowledge creation through open grassroots communities, DIY Science is branded as a counterpart to conventional mainstream science practices. However, the development of the DIY Science movement may not so much constitute the black and white dichotomy as is often suggested. Closer examination is needed and is likely to reveal hints of something that is an inherently more complex phenomenon.

DIY Science as Leisure: The Hacker Lifestyle in US Hacker, DIY Bio and Makerspaces, Sarah R Davies, Marie Curie Research Fellow @ University of Copenhagen, DK

The notion of DIY Science covers a range of distinct activities, many of which do not intersect with one another. The term may, for instance, refer to Citizen Science projects, where laypeople are involved as data collectors or analysts in large scale institutional science projects; public participation or engagement, where lay citizens carry out their own research or lobby or intervene so as to help set the priorities of institutional science; or informal grassroots science, such as that found in hacker, DIY Bio, and maker spaces. I will be concerned in particular with this final form of amateur science.

The growth of what have been called 'community digital fabrication workshops' (Hielscher & Smith 2014) has been met with excitement. Such workshops typically feature an informal structure, a set of emerging technologies combining digital design and control with physical fabrication (such as 3D printers, laser cutters, or low-cost PCR machines), and accessibility to the general public. They go by a number of names – DIYBio labs, hackerspaces, makerspaces, fab labs, hack labs, Tech Shop (the latter being a brand name) – and may also co-locate with related spaces, such as artist communities, co-working spaces, or start-up incubators. It has been argued that the scope such spaces offer for low-cost experimentation with physical objects and prototypes may trigger a 'new industrial revolution' of renewed manufacturing and/or biotech industry (e.g. Anderson 2012).

I will speak from findings from a research project that investigated the culture and practices of hacker and maker spaces across the US (including a number of DIYBio labs), and which involved visits to 14 spaces and 30 interviews. We found relatively little evidence that either interaction with institutional science or with innovation, in the form of entrepreneurship and business development, was a priority for the majority of those using hacker and maker spaces. Instead, those we spoke to framed themselves as participating in a 'hacker lifestyle'. The work they did within hacker and maker spaces, while extremely important to them, was often seen as part of a wider approach to life, one in which values such as agency, self-reliance, being proactive, curiosity, learning and sharing were key. Hacking was pursued as a form of serious leisure; as such, quality indicators such as 'coolness' or the approval of the community were more important than traditional tests of scientific value.

Main Discussion Outcomes

- The DIY Science's ethics seems to become relevant to create more transparent, socially robust and credible knowledge that inform policy and civic action. Again, ethics appears as a marker of quality in DIY practice.
- To DIY Science practitioners and in general with civic engagement there is a danger of transference of responsibilities previously attributed to the State (e.g. in health and mundane activities such as waste management) to citizens.
- The notion of citizenship is rather fuzzy in all these movements, especially in Citizen Science and DIY Science. What becomes of citizenship needs thorough attention and it is an essential question for those who investigate critically the development of activities that call for citizenry involve.
- Leisure, pleasure or simply lifestyle, are associated with the practices of DIY Science; in other words, not only innovation or desire to influence action are drivers of DIY practice.

Learning and Making in a DIY era

A Citizens University, Diana Wildschut and Harmen Zijp, Amersfoort University, NL

At Amersfoort University, citizens run their own research projects, ask their own questions and decide on how to gather and manage their data. In the project 'Meet je Stad!' citizens measure climate change

very locally. They develop their own sensors and data sharing platform, decide what, how and where to measure and what questions they want to answer. The participants educate themselves in doing measurements, statistics, philosophy of science etc. The goal is to get high quality results that are useful both for other citizens, local policy makers and scientists. The groups run into problems when trying to share data with professional scientists. Most issues have to do with either accessibility of scientific data or (perceived) quality of the citizens' data. It is important that results related to climate change and other global problems can be used by anybody. If we want to share data between scientists and citizen scientists, what barriers are there and how can we overcome them? Should we find a set of criteria for data quality and accessibility that is acceptable for scientists and manageable for citizens?

Questions about practices of DIY and open source in architecture, Liat Brix Etgar, Bezalel Academy of Arts and Design, Jerusalem, IL

The city of Jerusalem is a hub for political, civil and spatial inequality and ground for diverse and on-going civil struggles and instabilities within which top-down urban planning policies and practices play a major role. In this urban environment we find it crucial to develop tools, skills, collaborations and documentation for inhabitants in the city that seek to effectively act on urban issues that affect them.

Civil architecture is a developing field, which brings forth an alternative to top-down mechanisms of urban planning which are led by the neo liberal logic of economic growth, professional knowledge and structural power relations. Rather than accepting the need for hierarchical structures in knowledge and space formation, the ideas of civil architecture open up possibilities to develop dynamic and collaborative processes based on networks of knowledge and action. It adopts programmatic flexibility, tactical and temporal actions while adapting to constantly changing spatial and social needs.

Our projects are designed in the scale of the "neighbourhood". We think that is the most important socio-spatial unit that can nurture radical economical and architectural acts initiated by formal citizens, as well as by the most marginalized inhabitants. This is also the unit that creates the relation between the extra small data of the singular citizen and the big data of the city.

The greatest challenge we find in bringing together local and professional knowledge is developing the tools and methods for collaborative and sustainable praxis. Together with a strong community centre in the neighbourhood, which plays a significant role in bridging between the municipality and the residents, we established a centre for civil architecture and urban pedagogy that brings together the ideas and practices of the civil architecture unit with those of the *Public Laboratory for Open Technology and Science*, an open community which collaboratively develops accessible, open source, Do-It-Yourself technologies for investigating local environmental health and justice issues.
Our work is on-going, we try to learn together through our practice and we are dealing with some questions and conflicts we find relevant to the workshop:

- *Who is the initiator of the planning process?* In Israel the initiator of an urban plan is the local or the national government. The citizens are brought in the process only after the research was done and the main goals of the plan were determined. How can we encourage a different policy and practice through a valid neighbourhood research and a planning process that weave the local and professional knowledge into a qualitative urban plan?
- *Funding and sustainability:* There is a debate between the participants about the structure and the funding of the centre. The main conflict is around the possible funding of the local governance and the way it can affect the political and social independence of the centre and the quality of the planning process.

- *The exclusionary aspects of DIY*: We believe that open hardware and open source tools can take part in building communities and enable knowledge based social engagement. Nevertheless, our experience in Jerusalem problematises it by exposing the exclusionary aspects of DIY and open source practices and communities. By what means can we facilitate wider inclusion in urban planning process?

On Open Science, René von Schomberg[7], European Commission, DG Research

The Citizen Science trend is one of the trends towards Open Science. Open Science includes the general trend to include 'scientific knowledge' producers beyond the classical academic sphere, thus including also citizens. Open science operates through collective, globally networked and cooperative ways of addressing common challenges. It should be seen a response to and a correction of the scientific system with its overdue competitive "publish or perish" focus. Open Science, instead, has a focus on sharing knowledge as fast as possible.

Open Science has the potential to make science "better" since it can make Science more,

- reliable, as it allows early, better and more effective data-verification;
- efficient, as it can prevent useless duplication of similar research efforts elsewhere on the globe and extend collaboration to a broader range of contributors;
- responsive to the societal demands of citizens, as science could become more transparent and open than before;
- credible, as issues of research integrity could be better tackled in an open and transparent context;
- inclusive in the incorporation of a broader range of scientific knowledge producers beyond the academic context;
- global, facilitating internationally organised mission-oriented research, having scientists sharing knowledge and data prior to publication and thus advancing science at a faster pace and making innovations faster available.

Main Discussion Outcomes

- It must be clear that Citizen Science or DIY Science is not the same as Open Science. The latter may be functional to Citizen Science initiatives but it is not the same. Interestingly, it was suggested that there should not be a distinction between 'mainstream' and 'DIY' *science*; in other words Science is Science.
- The on-going discussion in other forums about data quality arising from the Citizen Science or DIY Science was prominent in this section. If methods used in DIY realms are not akin with scientific methods, then we need to think by which criteria we assure they are fit to the purpose they are meant to serve. Here context is a decisive driver. This is an area that already enlists a great deal of attention but needs to be further pursued.
- Inclusiveness of wider sectors of the society as well as, the resonance of issues dealt with with tangible societal challenges brought by Citizen and DIY Science are 'markers' of quality.
- 'Do it yourself' is actually most of the times 'do it together' and cooperation within the communities is a norm whereas cooperation between those communities and other institutions is considered deficient. The 'self' in DIY is connected to ideas of empowerment and agency.

[7] This is work in progress not to be quoted that does not represent a European Commission's point of view. Therefore, it may not, in any circumstances, be regarded as stating an official position of the European Commission.

- Arts and science are deemed as a natural combination; both forms of ways of knowing question the world in different ways. Both fundamental science and experimental arts are having a difficult time in funding schemes, and so, places are needed where these can thrive and mature in continuous dialogue.
- Collaborations among all ways of knowing are not only desirable but also need to be nurtured from/within school curricula.
- Attended value systems on what DIY Science does need to be reflected upon.

Hacking

Practices and Values of DIY Science: Openness, Ethics and Responsibility, Susana Nascimento, European Commission, Joint Research Centre

Anyone who is fascinated or curious about science and technology now finds a lower threshold to enter such realms, using DIY options, tools and spaces to build anything from scientific instruments for environmental measurements and for genome sequencing to satellites and other machines or devices. Low-cost sensors (for instance Co2, temperature, light intensity, sound, or humidity), programming languages, open-source hardware prototyping platforms or microcontrollers (such as Arduino or Raspberry Pi) are adaptable, modular and easy to use at a starter level. When also coupled with access to digital tools (such as CNC machines, laser cutters, or 3D printers) and also hand tools in shared spaces or workshops, a wider ground for experimentation emerges. Connection with online communities and access to online tutorials, step-by-step instructions and documentation repositories (such as Instructables or GitHub), greatly enable networks of support and collaboration with others with common interests. We will explore how DIY Science is recognizing different ways of knowing and learning, and thus allowing for more out-of-the-box thinking and experimentation, or more generally, how it is changing knowledge production and citizen agency.

We will also explore how DIY Science is defining and dealing with other understandings of openness, ethics and responsibility. For instance, a number of ethical discussions and controversies have risen, such as in DARPA's funding of educational initiatives like the MENTOR program developed by Dale Dougherty of O'Reilly Media (publisher of Make Magazine, and organizer of the Maker Faire), or the widespread concern towards DIYBio movement from policymakers, journalists and the general public regarding its safety, security and ethical guidelines. Another example refers to issues of inclusion and diversity that are visible in the practices and spaces of maker/hacker communities, thus prompting a discussion on engaging expanded groups of citizens and communities while addressing questions of power, gender, social and cultural capital, abilities and know-how, and national and local contexts.

Main **questions** I would like to propose:

- What are the possibilities of DIY Science for abridging dichotomies of experts and non-experts, towards the recognition of other legitimate forms of knowledge?
- In which spaces and according to which values and practices is DIY Science operating?

DIY Science: Worse is Better, Pedro Ângelo, University of Porto, PT

For those of us that are part of a Hackerspace, Makerspace or Open-Source community, there is a feeling that we are in the midst of a new age of wonder. Empowered by low-cost, accessible toolkits and ubiquitous Internet communication, many of us sense that it is possible to actively engage with technical and scientific topics that arise from a range of motivations, from personal curiosity to real problems that affect us and our communities. Our relationship with institutionalised Science is both of wonder and contempt. Wonder for the feats of scientists and the incredible knowledge that they placed at our fingertips and contempt for the institutional obstacles, the funding requirements and the expensive publications that keep us from engaging proactively with public mainstream scientific

discourse. But things are changing. The quality of DIY Science is slowly improving, with better instruments, more accessible learning resources, and more qualified people willing to review results and provide valuable feedback. "Worse is Better" is a common pattern in disruptive innovation where initially lower quality but accessible alternatives start by attracting neglected users and then steadily rise in quality and user base until eventually challenging and ultimately displacing established institutions. Are the institutions of mainstream Science about to face their "Innovator's Dilemma" in the face of DIY Science?

Alternatives to the "growth-centred" model, Pieter Van Boheem, Waag Society, NL

As pointed out by The Club of Rome in the past century, our current societal model is reaching its limits. Creatives and hobbyists, often organised in "DIY communities" are prototyping alternatives to the "growth"-centred model. Instead of the dogmatic 3% annual growth, this new network-empowered society is creating a "Zero Marginal Cost" model based on P2P (peer to peer) technology. The resulting distributed power system challenges the authority of democratic nation states, just like DIY Sciences counters market oriented universities and participatory arts question the position of museums. These old-fashioned institutes need to quickly adept their attitude towards DIY Science communities.

When it comes to DIY Science the strategies are not clear yet. Academic institutes can either aim to neutralise the disruptive force through a rapid institutionalisation or countering it by resistance. Anyhow, DIY Science and Academic Science will be perceived by the public through more or less the same lens when it comes to ethics and morality. So, a continuous conversation between both worlds is critical."

My questions would be:

- What challenges arise from institutionally supported DIY Science, either by NGOs, museums or knowledge institutes?
- What license model addresses the needs of DIY Science?

The Maker movement and the democratisation of the Internet of Things, Paulo Rosa, New University of Lisbon, PT

The Maker movement is inevitably associated with the principles of open source hardware and software. Makers are not only idealising and manufacturing their own new products using a variety of digital fabrication technologies but also making the product's "blueprints" freely available to others on the Internet for subsequent improvements. As a result, a new form of innovation is emerging. Each person is simultaneously the fabricator and the consumer of a product, which is fabricated, in a distributed fashion. This type of "appropriation" can allow us to re-imagining the Internet of Things vision as it best suits our needs. But what issues remain for quality?

Main Discussion Outcomes

- The language of 'hacking' is full of creative terms: "worse is better", "Zero Marginal Cost" of P2P (peer to peer) technology, disruptive innovation, free "blueprints", etc. leading to "community building", public or community knowledge, creative commons and open source, activism, saleable techniques, clandestine products in a myriad of areas, science, technology medicine, environment, ICT, etc.
- Interaction with mainstream is not clear yet; it is expected a number of equally different reactions: hostility, resistance, interaction or support. What is clear is that it cannot be ignored.
- DIY Science and mainstream Science are on the same page when it comes to ethics and morality.

- With DIY Science the fabricator and the consumer become hybridised. This is key for notions of empowerment.

What becomes of Excellence?

Excellence in science: what grounds to allocate public resources for research & innovation?, Sjoerd Hardeman, Joint Research Centre, European Commission

In an age of accountability, science is under ever more scrutiny by the public. Given the enormous amounts of public money that goes into science, it should come as no surprise that a responsible allocation of public resources for science has recently been frequently called upon. One response, the one particularly endorsed by the European Research Council and other European institutions, focuses calls for excellent research. That is to say, just as good science is preferred over bad science, if we are to get the most out of our public investments in research, it's also better to go for excellent instead of good science. Though laudable in the abstract, the call for excellence has been criticized on at least two grounds. One is that the notion of excellence, if not altogether ill-defined, runs the risk of becoming interpreted rather one-dimensional. A one-dimensional interpretation of excellence in turn might lead to a reproduction of reward structures in which some voices dominate equally legitimate others. Another criticism raised against excellence stresses the point that a focus on excellence does not discriminate among addressing problems of different societal importance. The issue here is that excellent research, as defined within the realm of science itself, need not be concerned with the most pressing societal problems, or what has been called grand societal challenges, per se. Both criticisms, however, offer more questions than answers. To start with the latter criticism: what counts (not) as a grand societal challenge? Who's in the right position to tackle such challenges? On what grounds and on whose account? As to the first criticism: what tools do we have to measure, monitor, and manage science's contribution to progress around the world? How can such tools be deployed for allocating resources for research, both among researchers addressing the same problem and among researchers addressing different problems of interest?[8]

Against Excellence, Jack Stilgoe, University College of London, UK

Excellence is everywhere. Following the Research Excellence Framework, the UK's Universities are all rushing to take credit for their 'excellence'. The UK Government's recent science and innovation strategy talks about "the importance of achieving excellence". Who'd be against that? If quality is good then surely excellence is better? I'm not so sure.

In November 2014, the 'Rome declaration' was published as part of Italy's presidency of the European Union. The statement calls for Europe to embrace 'responsible research and innovation', in the service of big social problems global health, environmental sustainability, and securing food, energy and water supplies. Few would disagree with the principle of responsible research and innovation. But it remains unclear what it would mean in practice. RRI will certainly involve doing some new things, but it also means addressing possible barriers in the de facto governance of innovation. One of the major

[8] Background readings:
Funtowicz, S. O., & Ravetz, J. R. 1994. The worth of a songbird: ecological economics as a post-normal science. *Ecological Economics*, 10(3), 197-207.
Hardeman, S., Van Roy, V., Vertesy, D. 2013. *An analysis of national research systems (I): A Composite Indicator for Scientific and Technological Research Excellence*. Brussels: Publications Office of the European Union.
Nowotny, H. (2006). Real science is excellent science–how to interpret post-academic science, Mode 2 and the ERC. *JCOM*, 5(4).
Power, M. 1994. *The Audit Explosion*, London: Demos.
Stilgoe, J. 2014. Against excellence, *The Guardian*, 19-12-2014; Available at: http://www.theguardian.com/science/political-science/2014/dec/19/against-excellence
Weinberg, A. M. (2000). Criteria for Scientific Choice, *Minerva*, I (2), 158–171.

obstacles to responsibility will be the way in which we talk about scientific 'excellence'. As currently imagined within Horizon 2020, scientific excellence is something other than, and a separate pillar from, work on 'societal challenges'. If we are to nurture a genuinely responsible research and innovation, our idea of 'excellence' needs a radical overhaul.

Social media, knowledge sharing and the disappearance of traditional gatekeepers, Lucia Vesnić-Alujević, Joint research Centre, European Commission

In my contribution, I focus on the knowledge production and sharing in the context of the Internet and changes it brought to the area of scientific publications. "Publish or perish" is a phrase often heard in scientific circles and the number and quality of publications are one of the main factors for academic promotions and assessing the quality of a researcher more broader. However, after the appearance of web 2.0, that is read-write web, where users have also become creators of the online content, we are witnessing certain transformations in academic publishing.

Although having papers published in leading journals of our respective fields is still very important, there are other ways how we can share our research results with others from the scientific community and even wider. With the appearance of social network sites created for academic communities, researchers stared to share their papers- mainly with their peers by uploading the non-edited version of the published paper (which is not protected under the copyright agreement).

Another possibility for scientific knowledge to be shared nowadays lays in internet tools and pages such as blogs or even micro-blogs, i.e. Twitter or Facebook, where broader community is almost always included and deliberates on someone's results. In that sense we can also talk about the disappearance of traditional gatekeepers seen in the role of the editor and 2 reviewers who had to agree for a paper to be published and could have stopped novel ideas that were too novel, too audacious or that they wanted to keep for themselves. This also opens the possibility for those who have interest and/or knowledge in a specific area but do not use the "scientific" vocabulary to be actively involved, share their results, but also ask questions.

Main Discussion Outcomes

- New modes of knowledge production cannot be disentangled from new modes of knowledge distribution and diffusion.
- Scientific excellence appears not to be a significant concept that describes the quality of science even in mainstream science. During the 1990s Helga Nowotny and colleagues problematized the notion of excellence with "MODE 2" production of knowledge. There was then a call for a redefinition of excellence among academics, institutional loyalties; etc. calling for broadening of the meaning. But what we can see today is that the required pluralising of the concept is not happening, instead being narrowed down in time. Responsible research and innovation, Open Science has only made this discussion urgent.
- The question has remained: is scientific excellence really about the quality of science? For the kinds of context we are examining at this workshop, that is not so, unless what counts as 'excellence' is broadened.

Quality Assurance in a DIY Era

Challenges for quality in DIY Science, Ângela Guimarães Pereira, Joint Research Centre, European Commission

In my initial statement I'll talk about different citizens engagement with science, from Citizen Science to DIY Science and outline what I see as major challenges for quality, including issues of framing and ethics when research funding is distributed and not subject to any type of societal or political agreements. My **questions** are related to co-existence of notions of quality and whether we need any conciliation.

Governance of DIY Science, Jerome Ravetz, Institute for Science, Innovation and Society, Univ. of Oxford, UK

For me the main importance of this workshop is in directing attention to DIY Science as distinct from Citizen Science. Of course they are related, but Citizen Science is essentially in dialogue with established institutions, a mixture of dependence, support and criticism. But DIY is, as the name implies, independent. Of course it depends on mainstream science in a variety of ways, as for materials and a knowledge base. But its activities are, in relation to the mainstream, ungoverned. This gives greater scope for creativity but also more scope for abuse.

My leading questions:

1. How will governance for quality assurance in DIY Science be managed in a socio-technical system that is ungoverned?

2. Can the 'creative commons' ethic be sustained through scaling-up, and can it then be transmitted back to the mainstream?

3. Can the malevolent uses of science and technology be excluded from the open DIY sector?

Science is in a state of crisis, Andrea Saltelli, Centre for the Study of the Sciences & the Humanities, University of Bergen, NO

Science is in a state of crisis. The Economist – a periodical - titles on his cover "How Science goes wrong" (2013).

The Economist's piece draws from and an increasing number of academic papers and editorials lamenting a drop in reproducibility and corresponding increase in retraction of scientific work. 'Unreliability in scientific literature' and 'systematic bias in research' are lamented by Boyd (2013, Nature). "Laboratory experiments cannot be trusted without verification", argues Sanderson for organic chemistry research (2013, *Nature*). 'Suspected work […in] the majority of preclinical cancer papers in top tier journals' is denounced by Begley (2013, *Nature*).

In a landmark study of results in cancer science Begley and Ellis were able to reproduce only 11 per cent of the original findings (2012).

The issue is not confined to natural and medical sciences. "I see a train wreck looming" warns Nobel laureate Daniel Kahneman with behavioural sciences in his sight (Yong, 2012); Joseph Stiglitz (2010), another laureate, condemns perverse incentives in the modelling of financial products at the hearth of the present economic recession.

The situation is so serious that a Meta-Research Innovation Centre (METRICS) has been launched at Stanford, involving John Ioannidis, to combat 'bad science' (The Economist, 2013; 2014). The same author contends that as a result of shoddy science as much as 85% of research funding is wasted (2014).

Could the movement known as 'Citizens' Science' respond to official science's predicaments (McQuillan, 2014) and 'pick up the gauntlet' thrown by official science's contested hegemony?

Funtowicz and Ravetz ask: "Is the internet to science what the Gutenberg press was to the church?" The subject is discussed in a piece entitled 'Peer Review and Quality Control' which they wrote for the International Encyclopaedia of the Social & Behavioural Sciences, 2nd edition, 2015.

I would like to discuss this little elegant essay[9].

Main Discussion Outcomes

- Mainstream science is in a quality crisis. Reality checking is missing. When the traditional institutions of quality assurance are not fully effective even in a favourable environment, how can we expect them to work in a new, fledgling and ill-understood practice like DIY Science? This needs further study.
- DIY Science is self-selecting to the extent that it is only those with real commitment who stay.
- Quality assurance (unlike quality control) is not only about the qualifiers, but about who qualifies and by what system are those quality assurers chosen. Quality assurance is about the total system. Hence, this term is preferred to refer to quality enquiries in all forms of scientific work.
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[9] References

Begley, C. G., 2013. Reproducibility: Six red flags for suspect work, *Nature*, 497, p. 433–434.
Begley, C. G. and Ellis, M. E., 2012. Drug Development: Raise Standards for Preclinical Cancer Research, *Nature*, 483, p. 531–533.
Boyd, I. Research: A standard for policy-relevant science. *Nature*. 501(12 September 2013), p. 159–160.
McQuillan, D., 2014, The Countercultural Potential of Citizen Science, *Media and Communication Journal*, 17(6)
Sanderson, A.B., 2015. Academic Attacks Greenpeace for 'Ignoring the Evidence' On GM Crops, *Breitbart*, 3 February 2015. Available at: http://www.breitbart.com/london/2015/02/03/academic-attacks-greenpeace-for-ignoring-the-evidence-on-gm-crops/.
Stiglitz, J. E., 2011. "Rethinking macroeconomics: what failed, and how to repair it", *Journal of the European Economic Association*, 9 (4), p. 591–645.
The Economist. 2013. How science goes wrong. p. 11. Available at: http://www.economist.com/news/leaders/21588069-scientific-research-has-changed-world-now-it-needs-change-itself-how-science-goes-wrong
The Economist. 2014. Combating bad science Metaphysicians. Sloppy. researchers beware. A new institute has you in its sights. *The Economist* (15 March 2014). Available at: http://www.economist.com/news/science-and-technology/21598944-sloppy-researchers-beware-new-institute-has-you-its-sights-metaphysicians
Yong, E., 2015. "How Reliable are Psychology Studies?", *The Atlantic*, 27 August 2015.

Reflections on Quality

With DIY Science, we start our analysis outside the charmed circle of 'scientists'. At the start, **we need to ask who has the right to be called 'scientist', and then by whom that right is conferred**. In the absence of established institutions for governance, we realise more acutely that doing science involves choices, that we inevitably leave most areas in ignorance. Again, who makes those choices, by what right do they do so, and to what extent are those choices public and accountable, become salient questions in the DIY context. The inevitable struggles to achieve worthwhile knowledge are here not buried in the objective language of research papers, or concealed in unpublished papers if unsuccessful. **Issues of quality and excellence, only recently becoming salient in mainstream science, are in the DIY context absolutely central.** Who judges quality, with what competence and by what right, are issues that cannot be avoided.

The practice of DIY Science does not merely raise issues about the conduct of science that had previously been underrated. In very practical ways, **it creates challenges to mainstream science with its reminders that alternative approaches and styles are possible**. By embedding science in communities, either local or issue-oriented, it highlights the isolation of most of mainstream scientific practice from the society that supports it. Similarly, DIY researchers are not institutionally alienated from the outcomes of their work. They must confront all the issues, practical, political and ethical, that arise from that connection. In that way, they inevitably become 'citizen scientists', and show that that is a natural and healthy status.

According to *Nature (2015)*, the public's trust in science is rather less affected by the recent scandals than it should be. But broad public attitudes are slow to change and then once underway such changes are hard to reverse. Within science, a serious breakdown of mutual trust, as in the peer-review and refereeing systems, could have consequences analogous to those we witnessed during the 'credit crunch' of 2008-9 (see for example, Horton, 2015; Lancet, 2015; Saltelli *et al.* forthcoming). The many initiatives to rescue science, as those for research integrity, could yet succeed in stopping the rot. For them, the question is how to counteract the effects of sheer size and scale, destroying 'communities' and requiring the use of 'objective' but corruptible metrics of quality, especially when these effects are compounded with imported commercial pressures and political imperatives, in a context where the idealism that motivated 'little science' is no longer plausible. **Could Citizen and DIY Science grow with sufficient speed and integrity to provide an effective example of another way to do science? That could be a crucial question for the future.**

For those who are familiar with the workings of science, the institutions of quality assurance are known to be complex, pervasive and powerful. In principle, the various gatekeepers control who can gain access to publication for their achievements, and even who can gain access to the resources necessary for their work**. Quality assurance in science is a remarkable institution, as it works largely informally on the contribution of unpaid busy volunteers. That it has worked so well in the past is a testament to the genuinely special quality of the world**

of science and scholarship. That it now comes increasingly under stress is a sign of the need for a new view of science, as a social activity and in society.

In his book, Jerome Ravetz (1971/1996) raised the question of preserving quality assurance in the transition from 'academic science' to 'industrialised science'. He saw that without the wellsprings of commitment to quality among the scientific leadership, degeneration would occur. For a source of rejuvenation, he posited a 'critical science', rather like the present Citizen Science but perhaps also extending to a metaphysical counter-culture. Being more realistic, an interaction with Citizen or DIY Science could now provide an important stimulus.

However, given the new challenges to mainstream science, the prospects for effective quality assurance in DIY Science are dubious. Without effective quality assurance, any sort of scientific activity, but especially that which lacks solid institutional foundations and constraints, is very much at risk from every sort of abuse: cranks, charlatans, liars, thieves, and malefactors. We have had a warning in the analogous problems in IT: hackers of every sort, along with criminals and terrorists. And **when the traditional institutions of quality assurance are not fully effective even in a favourable environment, how can we expect them to work in a new, fledgling and ill-understood practice like DIY Science?**

This challenge formed the background to the discussions at the workshop. Perhaps because the problem of quality assurance in science is not widely recognised anywhere outside a minority of specialists, this question remained unanswered at our workshop and is in need of further discussion. The session that addressed 'excellence' focused more on the problems as experienced in mainstream science. Many of the participants recognised it, and implicitly organised their contributions around it: **morale and commitment are the necessary conditions for effective quality assurance; in their absence vigilance will decrease and shoddy or dishonest work will ensue.** So, **the community aspect of DIY Science was stressed, deriving either from participation in a good cause, or involvement in an idealistic community**. For the purposes of the workshop, this was quite adequate. But these motivations will not continue to be fully adequate as the practice enlarges. So many other problems will occur, necessarily deeply modifying its social practice, that **we ought to continue exploring the transformations, including what we should be calling the challenge of quality**.

We concluded that the quality assurance discussions and mechanisms do not seem to be fully articulated in the DIY communities, at least on the ways we conceive of quality in mainstream science. Notions of excellence in this special context seem to be irrelevant.

The workshop reminded us that the current DIY Science is only at the start of a trajectory of great growth in size, self-awareness and significance. There will be many interactions with mainstream science; here we indicate a few. Looking at science from the perspective of DIY offers some very valuable insights. Traditionally our understanding of science has focused on what 'he' does, such as making discoveries, applying a Method, or bringing benefit to mankind. All those talking about science either scholars, teachers or publicists, have shared that perspective. Although questions of context have recently begun to creep in, the unquestioned core has been 'the scientist' doing an unproblematic 'science'.

There is no need for an essential opposition, or hostility, between the DIY and the mainstream sectors of science. **DIY Science certainly needs mainstream for its base in knowledge and technique, while we are now learning that mainstream can learn much from DIY Science.** We can expect that in some areas there will be contestation, while in others there will be collaboration and even blending. In the best case, DIY Science can provide a rejuvenating presence to science, and also help it to resolve its own social problems that have recently become salient.

There are other considerations, relating to another dimension of science, not so much as a social activity but as a basic means of production in modern society. We are now in the process of a matured industrial revolution in information technology. Its effects on the economy and culture are well chronicled and discussed. **It is not yet so clear, what are its effects on the production of scientific knowledge. And the phenomenon of DIY Science is clear evidence that those effects will be powerful.** We can think of the recent past as an era of concentration of production of science. A relatively small set of institutions, split between public-knowledge, state-corporate and private-corporate sectors, have dominated the quite considerable resources devoted to the scientific enterprise. Globally, the public-knowledge sector alone has commanded annual budgets well in excess of $100 billion (Lancet, 2015).

To appreciate the effects of the industrial revolution in information technology on this large and significant enterprise, we can reflect on the two phases of the modern European industrial revolution. The first, in the eighteenth century, was characterised by waterpower and textiles, and through its expansion it stimulated ancillary industries as well as mass markets. It was, of course, intimately related to prevalent imperialist political contexts and the destruction of industries and cultures overseas. Its stream of inventions and improvements eventually created the technological base for the next phase, first based on coal and iron, and eventually creating steel, chemicals and electricity through the Victorian age. Up to now, the effect of Information and Communication Technologies (ICT) on science has been to modify its practice, as through 'big data' and new routes to publication. But now the technology of knowledge production is being transformed. DIY Science has grown on the margins of existing knowledge technology. But now many costs are plummeting, and the financial barriers to participation in science are collapsing. When a CRISPR[10] gene-splicing machine costs only a few thousand dollars, participation in DNA science will not be constrained by institutional or even legal constraints.

We can see this embryonic revolution in the production of science in another perspective. As industry developed through its revolutions, the units of the means of production became ever more expensive so that their individual products could become cheaper. The handloom weavers were the first notable victims of this progress. A parallel process of capital-intensification has affected science, continuously up to the present. It was on this technological base that science became 'industrialised'. And now that the key technologies are shifting from the transformations of matter and energy to the manipulation of information, the

[10] This stands for 'clustered, regularly interspaced, short palindromic repeat' technology, which is an important new approach for generating RNA-guided nucleases, relevant for genome editing practices. See Sander & Young, 2014.

historical processes of capital-intensification are being reversed**. We suggest that the still marginal and often amateur DIY Science of the present is a harbinger of a new, diffused, means of production of science, whose modes and social relations are still to be imagined.** The challenge of quality will always be there, but it will be managed by means that are appropriate to its new context. DIY Science can indicate the way, if we have the opportunity to study it.

Although 'activist' Citizen Science has obvious political potential, it could be that ostensibly non-political DIY Science is in its way more normative and even radical. **DIY Science** is in its way yet more radical. This is because it **represents a deep change in the means of production of scientific knowledge, a breaking of the oligopoly of institutions who have hitherto commanded that enterprise.** These traditional institutions have worked within a very large and complex social system, which has been largely unexamined in its structures of control. That system is already experiencing an internal crisis of quality, and may well be losing popular support. The freeze in funding can be a sign of that.

Finally, nobody can anticipate what will be challenges from the DIY Science and Citizen Science sectors, but we all agreed at the workshop that they are sure to come. Some study of those impending interactions could be the most important thing that anyone can do, to secure the future of science.

References

Bonney, R. 2008. Citizen Science at the Cornell Lab of ornithology. In Robert E. Yager, John H. Falk (eds.), "Exemplary science in informal education settings": 213 - 229. Arlington, VA: NSTA Press.

Funtowicz, S.O. & Ravetz, J.R. 1992. Three types of risk assessment and the emergence of postnormal science. In S. Krimsky & D. Golding (eds.), *Social theories of risk* (p. 251–273). Westport: Greenwood.

Funtowicz, S.O. & Ravetz, J.R. 1993. Science for the post-normal age. *Futures,* 25(7), p. 739–755.

Guimarães Pereira, Â. and Saltelli, A. 2014. Of styles and methods. A quest for JRC's identity at times of change. Technical Report. EUR 26838 EN. Available at: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC91736/straw-man%20final-tr_register.pdf.

Horton, R. 2015. Offline: What is medicine's 5 sigma?. *The Lancet*, 385(9976), p.1380.

Irwin, A. 1995. *Citizen science: A study of people, expertise and sustainable development*. New York: Routledge.

Lancet, 2015. Rewarding true inquiry and diligence in research, Editorial, *Lancet,* 385, p. 2121.

Nascimento, S., Guimarães Pereira, Â., Ghezzi, A. 2014. From Citizen Science to Do It Yourself Science: An annotated account of an on-going trend. Science and Policy Report, EUR 27095. Available at: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC93942/ldna27095enn.pdf

Nature. 2015. Misplaced faith. The public trusts scientists much more than scientists think. But should it? Editorial, 2 June 2015, *Nature*, 522, p. 6.

Raddick, M. J., Bracey, G., Gay, P. L., Lintott, C. J., Murray, P., Schawinski, K., Szalay, A. S & Vandenberg, J. 2010. Galaxy zoo: Exploring the motivations of citizen science volunteers. *Astronomy Education Review*, *9*(1), 010103.

Ravetz J. R. 1971. Scientific Knowledge and its Social Problems. Oxford: Clarendon Press.

Riesch, H. and Potter, C., 2014. Citizen science as seen by scientists: Methodological, epistemological and ethical dimensions. *Public Understanding of Science*, 23(1), p.107-120.

Roy, H. E., Pocock, M. J. O., Preston, C. D., Roy, D. B., Savage, J., Tweddle, J. C., & Robinson, L. D. 2012. Understanding citizen science and environmental monitoring: final report on behalf of UK Environmental Observation Framework. Available at: http://www.ukeof.org.uk/documents/understanding-citizen-science.pdf

Rogers, H., 2011. Amateur knowledge: public art and citizen science. *Configurations*, *19*(1), pp.101-115.

Saltelli, A. , Ravetz, J., Funtowicz, S. 2015. (*forthcoming*). Who will solve science's crisis? In Saltelli, A. et al. (EDS) Science in the Verge. Amazon.

Sander, J.D. and Joung, J.K., 2014. CRISPR-Cas systems for editing, regulating and targeting genomes. Nature biotechnology, 32(4), pp.347-355.

Seyfried, G. Pei, L. & Schmidt, M. 2014. European do-it-yourself (DIY) biology: Beyond the hope, hype and horror. *Bioessays*, 36, 548–551.

Annex 1

AGENDA

@Amphitheatre 1, Bld 36

16 JUNE 2015

8.30	Welcome Coffee & Tea
9.00	Opening
9.30	Address by DG Vladimír Šucha
10.00	In conversation with: Citizen Science
11.30	Coffee & Tea Break
12.00	In conversation with: Learning and Making
13.30	Lunch Break
14.30	In conversation with: Excellence in Science
16.00	Coffee & Tea Break
16.20	Group discussions
16.50	Discussion
17:15	END DAY ONE

17 JUNE 2015

8.30	Welcome Coffee & Tea
9.00	In conversation with: DIY BIO
10.30	Coffee & Tea Break
11.00	Group discussions
11.30	In conversation with: Hacking
13.00	Lunch Break
14.00	In conversation with: Quality in a DIY era
15.30	Coffee & Tea Break
16.00	Group discussions
16.30	Final Discussion
17:15	END

IN CONVERSATION WITH…

Citizen Science:	Tom Wakeford [moderator] *with* Dan McQuillan, Jennifer Gabrys, Ron Salaj
Learning and Making:	Jerome Ravetz [moderator] *with* Diana Wildschut, Harmen Zijp, Liat Brix Etgar, René Von Schomberg
Excellence in Science:	Sjoerd Hardeman [moderator] *with* Jack Stilgoe, Jerome Ravetz,

	Lucia Vesnić-Alujević, René Von Schomberg
DIY Bio:	Mariachiara Tallacchini [moderator] *with* Ana Delgado, Christiaan de Koning, Sarah Davies
Hacking:	Susana Nascimento [moderator] *with* Paulo Rosa, Pedro Ângelo, Pieter Van Boheemen
Quality in the DIY era:	Ângela Guimarães Pereira [moderator] *with* Andrea Saltelli, Jerome Ravetz

LIST OF PARTICIPANTS

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Annex 2

Biographies

Pedro Ângelo is a PhD student in Digital Media at the University of Porto in the scope of the UT Austin|Portugal program and formerly an independent technical research consultant for creative projects. His research is focused on empowering artists to design complex distributed hardware systems for creative applications. He is also interested in other topics related with the intersection of technology and creativity like open-source digital fabrication, hardware hacking, and do-it-yourself tools. As a Free Software and Free Culture activist, he has been involved in the foundation and organization activities of the PortoLinux user group, the Portuguese Blender community, the Audiência Zero cultural association, and the AZ Labs network of Portuguese hackerspaces. He is also a member of the ARTiVIS research collective, looking at how art and technology can be combined for environmental purposes.

Liat Brix-Etgar is an architect, researcher and lecturer. She is the academic director of the Department of Architecture and the head of "Civil Architecture" Unit in Bezalel Academy for Arts and Design, Jerusalem. The unit interlaces design studio, political theory, planning and activism. It seeks to develop collaborative, open and deeply inclusive civil infrastructure, capacities and practices that would push towards democratizing planning processes. Liat received her B.Arch degree from the Bezalel Academy in Jerusalem and her M.A in philosophy (summa cum lauda) from the Tel Aviv University where she wrote her thesis about "The Spatial-Political Lexicon of Jean Luc Nancy". She is an architect and associate in Tehiru Group in Tel Aviv.

Sarah R Davies is Marie Curie Research Fellow in the Department of Media, Cognition and Communication at the University of Copenhagen, where her work focuses on science communication and public engagement with science. Her publications include the edited volumes Science and Its Publics (2008) and Understanding Nanoscience and Emerging Technologies (2010) and articles in journals such as Science Communication, Science as Culture, and Public Understanding of Science. Her current research explores hacking and hackerspaces, science communication and scientific citizenship, and care and caring within scientific practice.

Christiaan de Koning is a Visiting Fellow in the BioProperty programme at the Institute for Science, Innovation and Society (InSIS), University of Oxford. His research explores the governance of emerging biotechnologies. Christiaan especially focuses on understanding the quickly evolving political and regulatory landscapes that are brought into being by novel forms of transgenic life - with a particular interest in the divergent responses of different societies, in local and global contexts. To date, his empirical investigation has covered the contexts of the UK, Europe, Latin America, and now also explores India. Special attention is drawn towards grassroots initiatives, social innovation, DIY movements, transformational change, public health, GMOs, and global North-South relations. In October he will commence a Doctoral degree at the University of Oxford.

Ana Delgado is a senior researcher at the Centre of the Sciences and the Humanities, University of Bergen. She has a background in philosophy and social anthropology and holds a double PhD in environmental sciences and theory of science. She has done research on social movements, biology and governance. In her PhD she focused on the politics of biodiversity conservation, to lately include a focus on emerging technologies, particularly synthetic biology. Her main research concern is as to how science might become public. In her current work on DIYBio she aims at bringing together STS and political theory.

Jennifer Gabrys is Reader in the Department of Sociology at Goldsmiths, University of London, and Principal Investigator on the ERC-funded project, "Citizen Sensing and Environmental Practice: Assessing Participatory Engagements with Environments through Sensor Technologies." She is author of a study on electronic waste, *Digital Rubbish: A Natural History of Electronics* (University of Michigan, 2011); and a forthcoming study on environmental sensing, *Program Earth: Environmental Sensing Technology and*

the Making of a Computational Planet (University of Minnesota Press). Her work can be found at citizensense.net and jennifergabrys.net.

Ângela Guimarães Pereira works at the Joint Research Centre of the European Commission, holding a Ph.D. on Environmental Systems and their Tensions. In 1996 she started working at the JRC on European projects focusing on environmental and societal issues, future oriented activities and integration of information technologies with public engagement. Her work has been inspired by the post-normal science ideas developed by Ravetz and Funtowicz in the 1990s. At the JRC she currently works on knowledge assessment and ethics of ICT, critically investigating their governance and correspondence with current innovation narratives. She has authored a great number of peer-reviewed publications and is co-editor of Interfaces between Science and Society with Greenleaf in 2006 and Science for Policy: Challenges and Opportunities with Oxford University Press in 2009 and recently "The End of the Cartesian Dream" with Routledge. Her current interests lie in science history and ways of knowing; her favourite story is H. C. Andersen's 'the emperor's new clothes'.

Sjoerd Hardeman has worked on the economics of science and innovation, publishing in the interdisciplinary field of science and technology studies (STS). His research focusses on the quantitative analysis of science and innovation systems and theories of sustainable development indicators. After his undergraduate studies International Economics & Economic Geography at Utrecht University (The Netherlands), he completed his doctoral thesis at Eindhoven University of Technology (The Netherlands) titled "The distributed organization of science." At present he works as a post-doctoral researcher for the Econometrics and Applied Statistics Unit of the European Commission at the Joint Research Centre in Ispra (Italy). Here he primarily works on the construction of composite indicators in the field of science, innovation, and sustainable development.

Dan McQuillan is Lecturer in Creative & Social Computing at Goldsmiths College, University of London (http://www.gold.ac.uk/computing/). He has a Ph.D in Experimental Particle Physics and worked as Director of E-communications for Amnesty International. He is co-founder of Social Innovation Camp (http://www.sicamp.org/) and is the science & technical lead for the Citizen Science project 'Science for Change Kosovo' (http://www.internetartizans.co.uk/kosovo_science_for_change). Recent publications include 'Algorithmic States of Exception' http://research.gold.ac.uk/11079/. He tweets as @danmcquillan (https://twitter.com/danmcquillan)"

Susana Nascimento is Policy Analyst at the Foresight and Behavioural Insights Unit of the JRC / Joint Research Centre, EC / European Commission. She is also Associate Researcher at CETCOPRA / Centre d'Etude des Techniques des Connaissances et des Pratiques of University Paris 1 / Pantheoon-Sorbonne, and Associate Researcher at CIES-IUL / Center for Research and Studies in Sociology of ISCTE-IUL / University Institute of Lisbon. She holds a PhD in Philosophy from University Paris 1 and a PhD in Sociology from ISCTE-IUL. She currently works on future oriented technology analyses, transdisciplinarity and codesign for policy innovation, citizen engagement and participatory platforms, open science and technology, and new making and collaborative cultures.

Jerome Ravetz is a leading authority on the social and methodological problems of contemporary science. With Silvio Funtowicz he created the NUSAP notational system for assessing the uncertainty and quality of scientific information, and also the concept of Post-Normal Science, relevant when 'facts are uncertain, values in dispute, stakes high and decisions urgent' (see http://www.nature.com/news/policy-the-art-of-science-advice-to-government-1.14838). His earlier seminal work Scientific Knowledge and its Social Problems (Oxford University Press 1971, Transaction 1996) now has a smaller sequel, The No- Nonsense Guide to Science (New Internationalist 2006). His other publications include a collection of essays, The Merger of Knowledge with Power (Mansell 1990). He is currently an Associate Fellow at the Institute for Science, Innovation and Society at Oxford University.

Paulo Rosa has a Master degree in Environmental Management Systems from the New University of Lisbon and he is currently awaiting the defense of his Ph.D. thesis in Digital Media within the UT Austin|Portugal doctoral programme. In his Ph.D. research, Paulo explored how Printed Electronics are fostering novel solutions for the Internet of Things by enabling the production of extremely thin, flexible

and cost effective electronic circuits. It is established as well a connection with Personal Fabrication and the Maker movement, and how these can promote a new vision for the Internet of Things through the democratization of technology.

Ron Salaj works at intersection of social digital innovation, human rights and campaigning. Since 2010, Ron has been working for UNICEF Innovations Lab Kosovo (ILK), a unit of UNICEF Kosovo, where they look across sectors and fields to identify methods, technologies, and tools that promise to advance our service to children and youth. Ron has coordinated By Youth For Youth pillar of the ILK, empowering youth to transform their social impact ideas into actionable projects, providing young leaders with first-hand experience developing and implementing a projects, programmes, and social ventures. Since 2011, he leads digital advocacy and new media mobilization efforts of the ILK, equipping Kosovo's youth with the skills to engage with decision-makers through creative, sustained social and political action. He also co-ordinates Citizen Science project in Kosovo, where he is responsible for coordinating the work between different action groups, partners and stakeholders from Kosovo's civil society organization, media outlets, and institutions. He has extensive experience on human rights education and campaigning, where he worked with various human rights organizations and collective groups on defending and promoting human rights, including organizations such as Council of Europe, UNDP, etc. Most of times he tweets under @ronsalaj.

Andrea Saltelli has worked on physical chemistry, environmental sciences, applied statistics, impact assessment and science for policy. His main disciplinary focus is on sensitivity analysis of model output, a discipline where statistical tools are used to interpret the output from mathematical or computational models, and on sensitivity auditing, an extension of sensitivity analysis to the entire evidence-generating process in a policy context. A second focus is the construction of composite indicators or indices. Till February 2015 he led the Econometric and Applied Statistics Unit of the European Commission at the Joint Research Centre in Ispra (I), developing econometric and statistic applications, mostly in support to the services of the European Commission, in fields such as lifelong learning, inequality, employment, competitiveness and innovation. He participated to the training of European Commission staff on impact assessment. At present he is visiting researcher at the Centre for the Study of the Sciences and the Humanities (SVT) - University of Bergen (UIB), and a host at the Institut de Ciència i Tecnologia Ambientals (ICTA) -Universitat Autonoma de Barcelona (UAB).

Dr **Jack Stilgoe** is a Lecturer in Science and Technology Studies at University College London. He has spent his professional life in the overlap between science policy research and science policy practice, at the think tank Demos, the Royal Society and at UCL, where he teaches courses on science policy, responsible science and innovation and the governance of emerging technologies. He is a member of the Government's Sciencewise steering group and the Research Councils UK Public Engagement Advisory Panel and he is on the editorial board of Public Understanding of Science. Among other papers, pamphlets and other publications, he is the author of *The Public Value of Science* (Demos, 2007) and *Experiment Earth: Responsible Innovation in Geoengineering* (Routledge, 2015).

Mariachiara Tallacchini is Professor of Philosophy of Law at the Università Cattolica of Piacenza (Italy), and teaches Bioethics at the Faculty of Biotechnology of the University of Milan (Italy). After graduating in law, she earned a Ph.D. in Legal Philosophy (University of Padua), and was a postdoctoral fellow in the STS programme at the Kennedy School of Government (Harvard University). She is a member of several scientific and ethics committees in the fields of research ethics, genetics, xenotransplantation, animal and environmental protection. Between 2013 and 2015 she worked at the Joint Research Centre (JRC) of the European Commission. Her interests concern the legal regulation of science and technology, and the relations between science and democracy, especially in the life sciences and at the interfaces with ICT.

At Waag Society's Open Wetlab, **Pieter van Boheemen** develops projects, conducts research and workshops intertwining biotechnology, open innovation and arts. As founder of the Dutch DIY Bio community in 2012, he started a group of grassroots biotechnologists. Since 2013, he works in Waag Society's Open Wetlab and instructs, supervises and supports the users of the lab. His main interest is

investigating social and cultural innovation through the intertwining of open source hardware/software/wetware applied to synthetic biology, systems biology and bio informatics.

Lucia Vesnić-Alujević is a Postdoctoral Researcher at the Joint Research Centre. She obtained her PhD in Communication Science from Ghent University in 2011 with the focus on the political campaigning online, European public sphere, online citizenship and political participation. Since joining the JRC in 2012, she has been working on ethical and societal impacts of the emerging technologies. Her research focuses on intersection between communication studies and science and technology studies. She has been involved in several research networks and international projects and has published in the area of communication science, political science and STS.

Dr. Dr.phil. **René von Schomberg** is an agricultural scientist and philosopher. He holds Ph.D's from the University of Twente (NL) (Science and Technology Studies) and J.W.Goethe University in Frankfurt (Philosophy). He has been a European Union Fellow at George Mason University, USA in 2007 and has been with the European Commission since 1998. He is author/co-editor of 14 books, most recently edited books: The Future of Research and Innovation (in print 2015, Towards Responsible Research and Innovation in the ICT and Security Technologies Fields, 2011, *Understanding Public Debate on Nanotechnologies. Options for Framing Public Policy*, co-edited with Sarah Davies, 2010 and *Implementing the Precautionary Principle, Perspectives and Prospects*, co-edited with E. Fisher and J. Jones, E.Elgar Publishers, 2006

Tom Wakeford is Reader in Public Science at Coventry University's Centre for Agroecology, Water and Resilience. Under the guidance of Jerome Ravetz and many others, he undertook Citizen Foresight, the first citizens' jury on science policy, in the late 1990s. Later he used a "do-it-yourself" citizens' jury, based on participatory action research. Often working with grassroots-based organisations, he has used this approach on issues such as the rise of racism in the UK, older people's healthcare and the risks of industrialised food systems. Sometimes these approaches have achieved positive change, other times he has tried to join with others to collectively learn from mistakes.

Diana Wildschut is an artist, beekeeper and a theoretical physics student. She combines science and art and is interested in philosophy of science, complex systems, social innovation, grassroots organisations and Citizen Science. She is a co-founder of the Cooperative University of Amersfoort (in the Netherlands) and many other bottom up initiatives.

Harmen Zijp is visual artist and theatre maker. Interested in decision making processes, patterns of empowerment and peer production. Developing computational methods: genetic algorithms for spatial development, analysis of historic water management systems, playful interaction of scientific models and data.

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